TRAINING MANUAL FOR AGROECOLOGY BUSINESS ACTORS IN VEGETABLE VALUE CHAIN

PRODUCED BY: THE CGIAR INITIATIVE ON AGROECOLOGY, KENYA

December 2024

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INTRODUCTION

Agroecology is sustainable farming that works with, not against, nature. It explores interactions between plants, animals, humans and the environment within agricultural systems. Agroecology promotes application of ecological principles to agricultural systems, focusing on the sustainable management of natural resources and biodiversity (Vikas & Ranjan, 2024; Wezel et al., 2020; Sinclair et al., 2019). Agroecology blends science, practice, and social movements to design and manage sustainable farming systems that are environmentally sound, economically viable, and socially just. Vested on13 principles, agroecology aims to address challenges facing agriculture and food systems in a myriad of ways (HLPE, 2019). These involve enhancement of soil health, conservation of biodiversity, increasing climate resilience, reduction of environmental degradation, promotion of food security and nutrition, supporting smallholder farmers, encouraging social and economic equity, and fostering circular economies, among others.

This manual was produced to help promote scaling of agroecological practices under the Accelerator Program of the CGIAR Initiative on Agroecology. Through the program, agroecology experts from the Initiative collaborated with the private sector partners working on organic input production (vermicompost) in Kiambu, Kenya, to train producers on appropriate application of organic fertilizer, production of vermicompost and appropriate handling of commodities post-production. A total of 45 Trainers of Trainees (ToTs) were trained, and they continue to use the manual to train other producers in their neighbourhoods.

This manual can be used by others to promote scaling of agroecological principles under different contexts in the green leafy vegetable value chain, through offering trainings, knowledge sharing and dissemination, as well as promoting scaling and adaptation of agroecological practices. Even though the manual is applied on green leafy vegetable farming, it can be used on different commodities.

The manual covers several sections. First it starts with a general introduction to agroecology, which details its 13 principles, practices, transition levels and exclusion criteria for non-agricultural practices. In addition, it covers good agriculture management practices, touching on environmental management, farm management, food safety and post-harvest handling. The manual also introduces the aspects of Integrated Soil Fertility Management (ISFM), Integrated Pest Management (IPM), preparation of compost manure and neem concoction, alongside understanding plant nutrients in the soil and identification of their crop deficiency symptoms.

The manual further provides information on indigenous vegetable production, involving nursery establishment and management; examples of common indigenous vegetables and their production, alongside a step-by-step guide for planting and management of vegetables using vermicompost. Moreover, the manual covers the common vegetable pests and their organic control methods. Finally, the manual provides details on the preparation and use of vermicompost, that close with practical field demonstrations

INTRODUCTION TO AGROECOLOGY

Introduction

Agroecology is the study of interactions between plants, animals, humans and the environment within agricultural systems. It is a combination of science, a set of practices and social movement geared towards transformation of food and agricultural systems through optimization of interactions between plants, animals, humans and the environment.

- **As a science**, agroecology investigates the ecological processes and interactions in agricultural lands. It integrates ecology of food systems, agroecosystems, plots, fields and herds.
- **As a set of practices,** agroecology entails the integration of technologies or sustainable practices.
- **As a social movement**, agroecology entails sustainable agriculture, environmentalism and rural development aspects

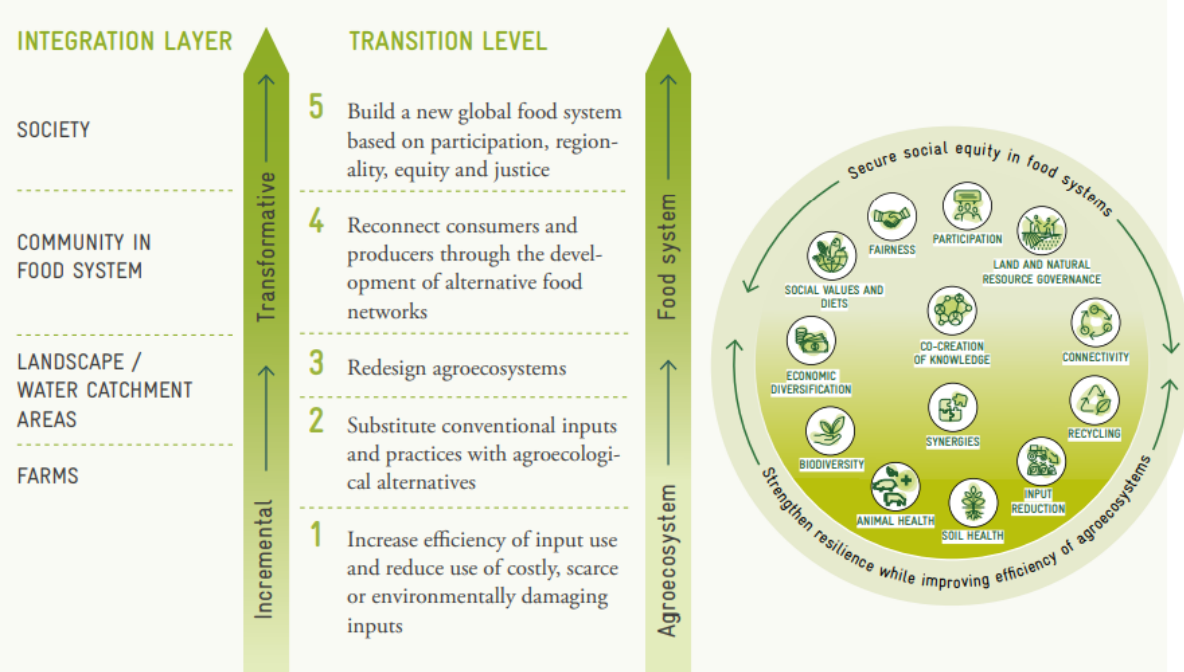
An intervention is considered **agroecological** if it **adheres to the 13 principles** and meets the **internally agreed exclusion criteria**.

The 13 Principles of Agroecology

Agroecology is anchored on **13 principles** (HLPE, 201**9),** each with certain practices that foster adoption of holistic approach to sustainable food and agricultural systems.

1. **Recycling**: Preferentially use local renewable resources and recycle nutrients and biomass
2. **Input reduction:** Reduce or eliminate dependency on purchased inputs and increase self-sufficiency
3. **Soil health:** Secure and enhance soil health and functioning
4. **Animal health:** Ensure animal health and welfare.
5. **Biodiversity:** Maintain and enhance diversity of species, functional and genetic diversity
6. **Synergy:** Maintain ecological interactions
7. **Economic diversification:** Diversify on-farm incomes
8. **Co-creation and sharing of knowledge:** Enhance co-creation and horizontal sharing of knowledge including local and scientific innovation, especially through farmer-to-farmer exchange
9. **Social values and diets:** Build food systems based on the culture, identity, tradition, social and gender equity of local communities
10. **Fairness:** Support dignified and robust livelihoods for all actors engaged in food systems, especially small-scale food producers, based on fair trade, fair employment and fair treatment of intellectual property rights.
11. **Connectivity:** Ensure proximity and confidence between producers and consumers through promotion of fair and short distribution networks and by re-embedding food systems into local economies.
12. **Land and natural resource governance:** Strengthen institutional arrangements to improve, including the recognition and support of family farmers, smallholders and peasant food producers as sustainable managers of natural and genetic resources.
13. **Participation:** Encourage social organization and greater participation in decision-making by food producers and consumers

AGROECOLOGICAL PRACTICES, EXCLUSION CRITERIA AND TRANSITION LEVELS OF AGROECOLOGY

The exclusion criteria	**Agroecological practices**	**The five transition levels of agroecology**
In order to be termed agroecological, a practice/project cannot: i. Focus on the introduction of GMOs and associated genome-editing technologies, ii. Focus on the promotion of synthetic fertilizers and pesticides, iii. Focus exclusively on promoting large scale single cash crop production at the expense of diversified strategies, iv. Focus exclusively on productivity resulting in avoidable destruction of vital eco systems and their functions and services, v. Promote regulations and/or actions that hamper and/or destroy local and farmer managed seed systems, vi. Focus on large-scale intensification of animal production, vii. Exclude or actively discriminating against women and other marginalized groups, viii. Focus exclusively on promoting highly processed or industrially produced food (with low nutrient value), ix. Promote extractive raw material production that depletes local resources over time, x. Promote approaches that violate rights, including customary rights, ignoring prior informed consent or results in population displacement and/ or land grabbing	• Crop Rotation and Diversification • Agroforestry • Conservation Agriculture (No-Till Farming) • Cover Cropping • Biological Pest Control • Integrated Pest Management – IPM • Composting and Organic Fertilizers • Sustainable Livestock Integration • Permaculture • Polyculture • Integrated Nutrient Management • Soil Conservation • Water Conservation • Livestock Integration	Level 1: Increase resource efficiency in order to reduce the use of scarce, costly and/or environmentally harmful external inputs. Level 2: Substitution of conventional inputs and practices by agroecological alternatives. Level 3: Redesign of agroecological systems so that they function on the basis of ecological processes. Level 4: Re-establish a more direct connection between food producers and consumers and develop alternative food networks. Level 5: Build a new global food system, based on equity, participation, fairness, justice and regionality. 

GOOD AGRICULTURAL MANAGEMENT PRACTICES

Good Agricultural Practices (GAPs) are principles, standards, and codes of practice that address environmental, economic, and social sustainability for on-farm production and post-production processes. In agroecology, GAP practices are important linkages in ensuring production of safe and healthy foods while protecting the environment and ensuring social and economic viability. The GAPS under the following sections should be observed:

Good Agricultural Practices (GAPs)

1. **Environmental Management and Conservation.** The following apply:

i. **Water Management:** Use **drip irrigation** to reduce reduces water use when possible; **Harvest rainwater** in reservoirs for use during dry periods.

ii. **Integrated Pest Management (IPM);** Use **natural predators** like ladybirds, Syrphid fly larvae, Green lacewing larvae and Damsel bugs to feed on aphids, mealybugs, thrips, spider mites, caterpillars, leafhoppers among others. Alternate pesticide use to reduce resistance buildup. Use **parasitoids** like ***Trichogramma* wasp** that attacks eggs of pests of more than 200 pest species preventing from hatching.
The principles of IPM: monitoring pests, using biological control, cultural practices, and chemical control as a last resort. IPM has environmental, economic, and health benefits.
Pests: insects, weeds, etc; understand their life cycle for effective management.
Control strategies: Cultural, biological, mechanical, behavioral, chemical (last resort)
Safe pesticide use: Understand labels, have personal protective equipment, properly store, handle, dispose chemicals.

iii. **Integrated Soil Fertility Management;** do soil testing; practice crop rotation, use

2. Farm Management: The following apply:

Irrigate when necessary.
Establish a monitoring system for pests, diseases, and soil conditions. Keep detailed records of all farm activities.

Types of records to maintain:

Planting (date; variety, location, spacing); growth and maintenance (fertilization, pruning, pest/disease control, irrigation); Harvest (dates, quantity; quality); post-harvest (sorting and grading; packaging); Financial records (expenses, income; profit, loss); Market (sales, prices, etc)

3. Food Safety and handling. Observe the following:

***Pre-Harvest Practices:** Do not apply pesticides close to harvest time; Follow recommended pre-harvest intervals to ensure that pesticide residues on vegetables are within acceptable limits; Inspect for signs of pests or diseases regularly.

***Harvesting:** Harvest vegetables at the right time, preferably early in the morning or in the evening. Be careful not to break or bruise them. Harvest those of good quality. Follow proper harvesting intervals of harvesting, preferably two-week intervals.

4. Post-harvest handling. Do cleaning to remove dirt and residues from vegetables. Sort and remove damaged, diseased or rotten leaves if any; Properly package, avoiding breaking the leaves and use appropriate mode of transportation.

COMPOST MAKING PROCEDURE

Make 3 rectangular pits (150 cm x 150 cm x 30 cm; L,W,H)
Arrange the materials in layers from the bottom as follows; start with thick fibrous materials e.g dry twigs (10cm); dry vegetation e.g grass (10 cm); Sprinkle water after every layer added. Repeat the entire process until the heap is about 150 cm. Put a final layer of topsoil (5cm), cover entire heap with dry vegetation like banana leaves and insert thermometer stick. Turn over the compost to the second pit after 2-3 weeks and to the third pit after 2-3 weeks again. Store compost well and apply appropriately to the crops.

PREPARATION OF PLANT CONCOCTIONS

Gather green leaves from your preferred plant. Pound the leaves in a mortar. Mix the plant infusion with 10g non-perfumed soap solution; cover tightly and let it rest in a cool place for 24 hours. Dilute the infused plant material by mixing in an equal amount of water (5 litres), shake well and strain/sieve before use (Use kitchen sieve or muslin cloth to eliminate any leaf particles)

Procedure for Making Neem concoction

- Weigh 2 kg of fresh succulent leaves
- Crush them well using paste and motor
- After crushing, put the crushed materials in a bucket
- Add 5 liters of cold water and stir
- Prepare foam bubbles using 10g of bar soap in 1 liter of cold water. The soap should not have a scent.
- Mix the 5 litres of water with 1 litre of neem leaves and 1 litre soap bubbles in a bucket
- Cover the bucket and keep the mixture in a cool place for 24 hrs.

quality seeds, mulch, organic inputs, residues, compost together with other inputs	decomposed manure (2 cm); sprinkle wood ash; green leguminous material (15-20 cm); topsoil (2 cm).	• After 24hrs remove the lid, shake well, add 5 litres of cold water, and stir well. • Sieve the mixture before use. • The lifespan is 7 days after preparation.

INTRODUCTION TO INDIGENEOUS VEGETABLES PRODUCTION USING VERMICOMPOST

Vegetable Nursery Establishment and Management

Nursery: A nursery is a protected seedbed for raising planting materials before establishing them in the main field

Nurseries are established where: Seeds are too small to be sown directly in the main field; Seedlings are delicate when young hence require extra car; Management is eased by watering, weeding etc.

Site selection and preparation: Located near water source; secure; easily accessible; away from tree shade/runoff channels; climate suitable for the crop

Types of nurseries: Vegetable nurseries, fruit, tree

Characteristics of good media for nursery establishment: A good nursery substrate should be light in weight and easy to transport; Have good water holding capacity, aeration and drainage; Free from weed seeds, nematodes and other pathogens; Has adequate fertility (should contain all necessary nutrients for plant growth and development); be readily available; and relatively inexpensive

Equipment needed for making a nursery: hoe, spade, rake, and shovel; sieve; watering can/hose with nozzle; wheelbarrow

Nursery preparation:

Nurseries can be established in form of **Seed beds** (raised or sunken) or **Movable beds (Flats)**, Seed boxes and containers.

Raised nursery beds: These are suitable in rainy areas. Fertile and healthy soil is required. The soil should be loam to sandy loam, loose and friable, rich in organic matter and well drained.

Making the raised beds: Select site and clear grasses and weeds. Measure 1metre wide and any length – should be east to west oriented to facilitate light penetration, minimize effects of heat and to welcome light rays. Loosen the soil 1 feet deep and pour 1 wheelbarrow of well decomposed and fine compost per every 3 meters and mix well in the soil. Prepare beds as **1m (width**) by **3-5 m (length**); Raise beds to 15 -20 cm high from the ground level leave a space of 30 - 40 cm between two beds for weeding, management and draining of excess rainwater. Rake the bed into a uniform size. Make drills or furrows across the bed at 10 – 15cm apart. Spread seeds thinly and cover with a thin layer of soil. Beds are firmed by palm after sowing to ensure close contact between soil and seeds. Sprinkle water after firming. Mulch after first watering

Nursery management practices

Security: Fence the area around the nursery

Bed cover- cover the nursery bed after sowing.

Use mulch to maintain the soil moisture and temperature for better seed germination; suppress the weeds; protects nursery from direct sunlight and raindrops; protect against bird damage.

Watering: Water twice a day (morning and evening) using sprinklers or manually. Drain out excess rainwater or irrigated water. Watering depends upon the weather condition; no watering when soils are wet.

Thinning -Thin to remove weak, unhealthy, diseased, insect pests damaged and dense plants. Thinning allows light and air to each and every plant; and also helps in watching the diseased and insect pest attacked plants while moving around the nursery.

Pricking out – Transplanting small seedlings to a new seedbed to give them more room.

Weed control: Do timely weeding

Potting or transplanting: Do timely **t**ransplanting **Prevention and control from pests and diseases**- use fertile soil, crop rotation, maintain hygiene, use natural remedies, avoid congestion of seedlings and damp conditions.

Fertilization – Use compost manure while sowing

Hardening-off -Hardening-off – the seedlings to train the seedlings to adapt to adverse conditions in the planting sites. In this process seedlings are given some artificial shocks at least 7-10 days before uprooting and transplanting. These shocks include: Exposure to the full sunlight; Removal/ opening shading nets of all the shedding nets, polythene sheets; Irrigation is stopped slowly and slowly-reducing watering intensity; cutting the overgrown roots, opening shading nets, and no fertilizer application.

Transplanting: preferably done in the afternoon or during cloudy days. Water seedlings before uprooting and remove seeds with damp soil around their roots and do not leave them lying for too long. Water the holes before transplanting. Place the seedlings in the hole and pack the soil around it and firm gently. Water the transplanted seedlings well to settle the soil

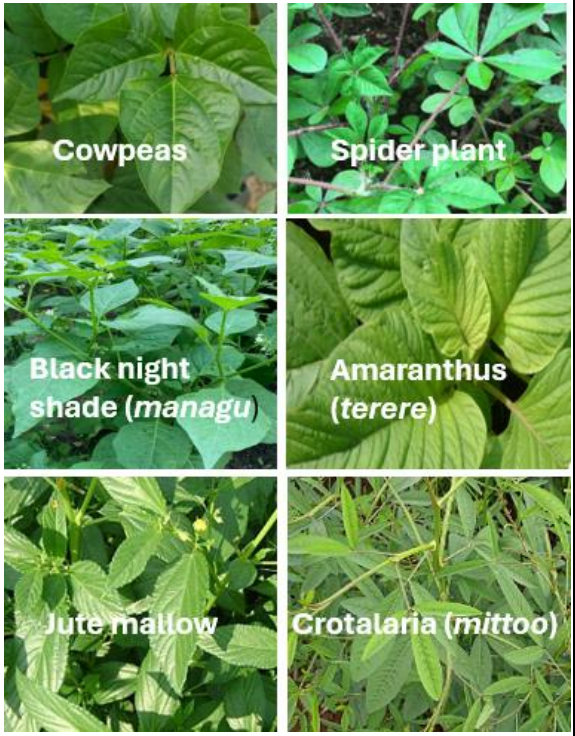
Benefits of a plant nursery: Careful tending of plants at a young stage; maximise space; reduce labour; protects plants from harsh conditions

Removal of mulch-Carefully remove the mulch after about three days, observe the seed beds daily.

Use of shedding net-After seed germination during the seedling growth, if there is very high temperature (> 30°C) then beds should be covered by 50% or 60% shedding nets about 60 – 90 cm above ground by the use of suitable support.

Indigenous vegetables are plant species that are consumed in specific locations as part of traditional diets. They are locally important for human nutrition, health and sustainability of economies.

Examples of most common indigenous vegetables:



Vegetables contribute to food diversity and security, especially in regions where access to a variety of foods may be limited. Growing vegetables, especially with agroecological practices, can improve soil health and nutritional safety and security

Steps in Production of Most Vegetables

1.Land preparation

Land preparation is very important:

- It improves **site condition**; improves **soil aeration** and **moisture retention**. Raised bed technique is commonly used for most vegetables.

1.1 Raised bed preparation

- Choose easily accessible site; receiving about 6-8 hrs. sunlight daily
- Measure **4m X 1.5m,** length and width, on both sides
- Clear the measured area and remove any weed or debris
- Loosen the soil for better root penetration and drainage.
- Mix the soil with vermicompost and make a raised bed.

2. Transplanting

- Seedlings are first raised in a nursery bed
- Better harden off seedlings prior to transplanting
- Only healthy seedlings should be transplanted

3. Management practices

3.1.Weeding: Do timely weeding to increase yields.

Reasons for weeding: Weeding **minimizes the competition** for resources, giving plants better conditions to grow; **reduces pest and diseases infestation;** increases yield. Remove weeds **as soon as they emerge** and before the flowering

3.2. Water requirement

Water frequently to reduce water stress, improve growth and yield. Irrigate sandy, sandy loam, clay loam and loam soils; 3, 2 and 1 times a week, respectively.

3.3. Fertilizer application: Apply vermicompost at 100 g per planting hole during transplanting and also during topdressing.

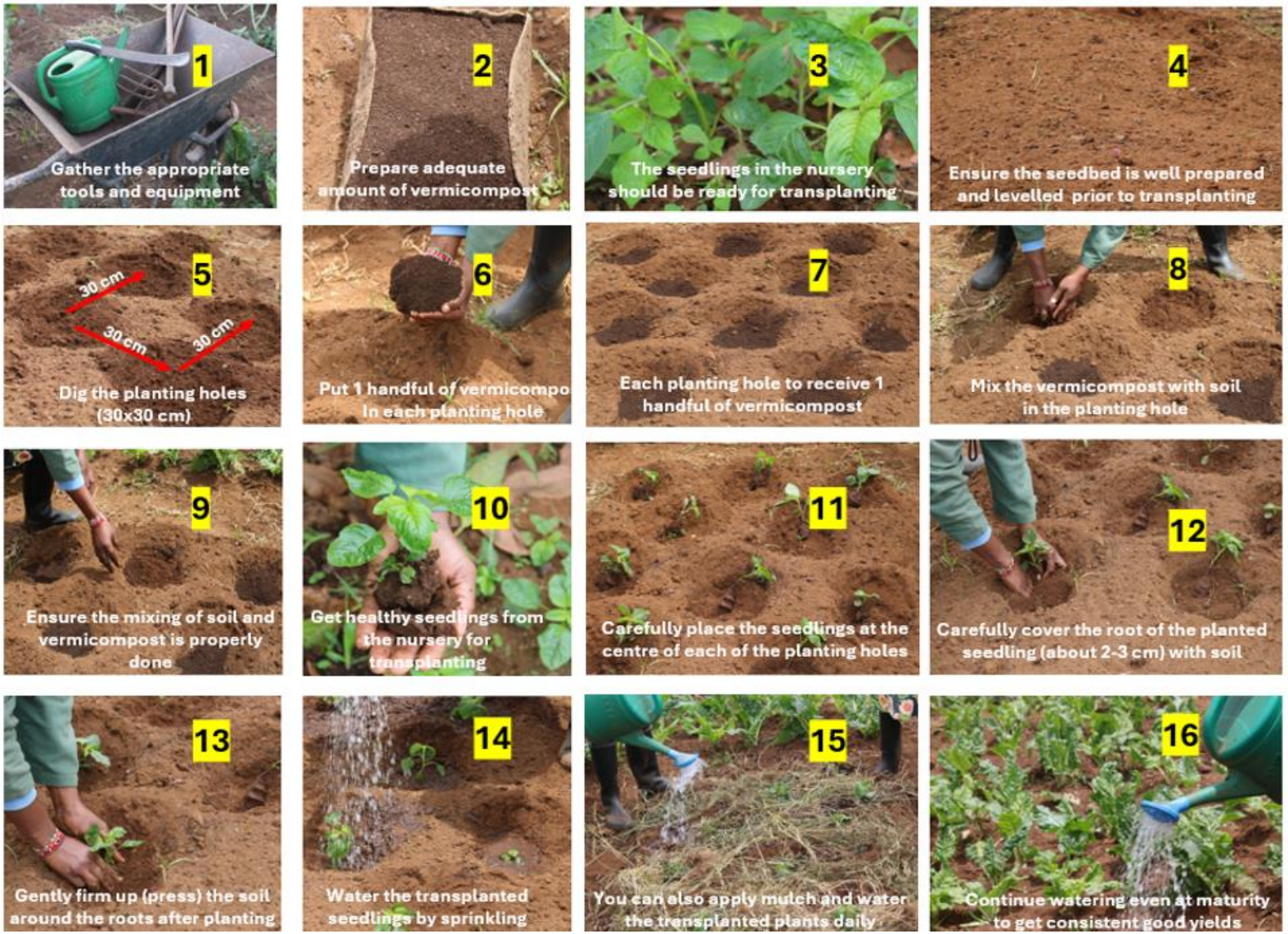
3.4. Pest and disease management continuously control or manage pests and diseases appropriately. Control may involve planting repellants crops like the spring onion, rotation, cultural methods, mechanical methods, biological methods, use of organic pesticides or biopesticides, etc. The application of vermicompost can be used to repel some pests.

The major pests of black night shade: root knot nematodes, cutworms, flea beetle, aphids. The major **diseases** are early blight and bacterial diseases.

3.5. Harvesting: Most vegetables are often ready for harvesting after 6-8 weeks after planting. The leaves can be harvested by cutting them off at the base of the plant, leaving the roots intact. Regular harvesting weekly or every two weeks can prolong the

Importance of vegetables They are rich in essential vitamins, minerals, fiber, and antioxidants. They provide key micronutrients like potassium, folate, and vitamin A, which are vital for body function, growth, and development, especially important for children and pregnant women. Also, a source of income/employment for many smallholder farmers.	• Transplant 30 days after sowing or after attaining 5-6 true leaves. Plant when they are about 10-15 cm in height. • Always get seedlings from a reputable source • Spacing of 15cm X 30cm in and between the rows is okay • Make good holes and apply organic inputs • Apply 100 g of vermicompost in the planting holes and plant your seedling to about 3cm • After planting, water the seedlings, cover your beds with mulch to retain moisture and also to suppress the weeds.	harvest period. The leaves should be washed after harvesting. The leaves can be dried before packaging as a value addition.  

STEPS FOR TRANSPLANTING SEEDLINGS USING VERMICOMPOST



COMMON VEGETABLE PESTS, PLANT NUTRIENTS AND IDENTIFICATION OF THEIR DEFICIENCY SYMPTOMS

The Common Vegetable Pests

Organic Control methods: Use **natural predators** like **ladybirds**, Syrphid fly larvae, Green lacewing larvae and Damsel bugs to feed on aphids, mealybugs, thrips, spider mites, caterpillars, leafhoppers among others. Alternate pesticide use to reduce resistance buildup. Use **parasitoids** like **Trichogramma wasp** that attacks eggs of pests of more than 200 pest species, preventing them from hatching. Can also plant repellant crops. Also

Role of Various Important Plant Nutrients

1. Nitrogen (N): This is the major nutrient for plant growth. Excess nitrogen fertilization may scorch the vegetables and should be avoided.

2. Phosphorus(P): Phosphorus fosters proper root development. Too much phosphorus should be avoided as it can cause eutrophication. They are poorly soluble, with slow soil uptake, affected by low pH and high iron.

3. Potassium (K): Is important as it increases root growth and improves drought tolerance.

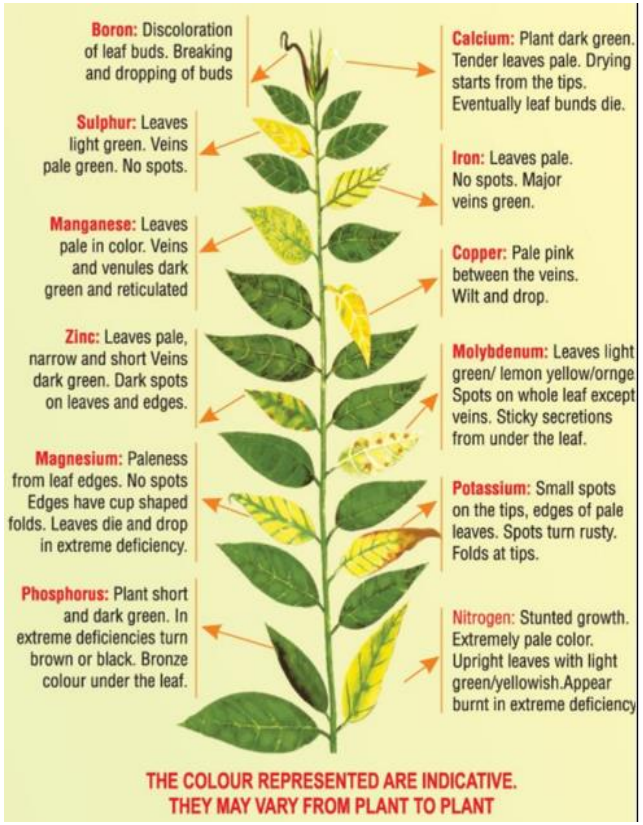
4. Calcium (Ca): This can be applied to acidic soils as dolomite, natural and tri-calcium phosphate or gypsum. It is required for structural roles in the cell wall and membranes. It also improves plant vigor and N uptake.

5. Magnesium (Mg): Helps in chlorophyll formation. Its deficiencies mostly affect old leaves. Applied as dolomite (in acidic soils) or magnesium sulphate base soils.

6. Boron (B): Boron is important for cell wall formation and stability, maintenance of structural and functional integrity of biological membranes, movement of sugar into growing parts of plants and hormone development. It can be sprayed as foliar to meet instantaneous boron demand.

7. Zinc (Zn): In vegetables, zinc is involved in chlorophyll formation in combination with iron and manganese. It activates enzymes that are responsible for the synthesis of certain proteins. Excess phosphorus can lead to zinc deficiencies as reflected by the emergence of smaller leaves, at the tips of new shoots, whose limb has discoloration between the veins

Identification of Crop Nutrient Deficiency Symptoms



spray with appropriate botanical pesticides like extracts from neem leaves, pawpaw, pepper, marigold or tithonia.	  	

BASICS OF VERMICULTURE: PREPARATION AND USE OF VERMICOMPOST

Vermiculture: The rearing or cultivation of worms.

Vermicomposting: The process in which the earthworms convert the organic waste into mature nutrient rich compost called the vermicompost or vermicasting.

Objectives of Vermicomposting

- To prepare vermicompost using wastes.
- To enhance recycling and management of waste materials
- To produce natural excrement of exceptional quality for the naturally starved soil.
- It helps to avoid the environmental pollution and minimizes expenditures of resources on treatment of the organic wastes.

Principles of vermicomposting

- This process is mainly required to add nutrients to the soil.
- Compost is a natural fertilizer that allow easy flow of water to the growing plant.
- The earthworms eat the organic matter and produce casting through the digestive system.

Types of worms

Earthworms fall under three categories defined by the part of the environment they predominantly inhabit. They include Epigenic worms (surface dweller) that live above the soil level; Endogenic worms which live below the ground; and Anecic worms which live below soil level but sometimes explore above soil level to find food.

Examples of worms used for vermicomposting.

They include; African night crawlers; European night crawlers and redworms (red wrigglers). The best type of worm for vermicomposting are the redworms (Eisenia fetida)

Housing for the worms

There are two types of structures to look at when raising the worms: **(i)The outer structure, (ii)** The **bed/bin** they're placed in.

The outer structure protects the beds/bins from both the sun, rains and also the predators, and should be set up in an ideal location factoring in; availability of raw materials, shade, water availability and level ground for construction.

The bin or the bed is made in many different dimensions depending on the quantity of materials to be used, availability and costs. The structure is either made of wood or plastics, metallic units are not ideal as they will easily corrode thus affecting the whole process.

Materials for vermicomposting preparation

These may include: any type of biodegradable wastes like crop residue, weed biomass, vegetable waste, leaflitter, waste from agro-industries, urban and rural waste, cattle dung

Feeding of the worms

Worms feed on the decaying and rotting organic matter, breaking them down into particles that can be fed on by bacteria and fungi. The worms' excreta(vermicast) produced are rich in nitrates and minerals such as phosphorus, magnesium, calcium and potassium

Materials to avoid feeding the worms

Avoid feeding the worms on cooked foods, citrus fruits, chicken waste or any animal waste that is high in ammonia, processed foods

Breeding of the worms

Worms are hermaphrodites, each having male and female organs. The young ones are hatched from tiny cocoons. About 2-3 baby worms are often hatched from each cocoon every 3 weeks.

Reproduction may be enhanced by proper feeding, balanced diet, enough moisture and space; and vice versa.

The worms will move over to the new organic waste in search for food. After some time remove and sieve the vermicompost until the old vermicompost is over. Then add some new organic waste on the other side until is completely filled and vermicomposting process continues again.

Procedure of vermicomposting

Collect the materials to be composted from the farm e.g cow dung, plants and vegetable waste. Put the materials in a container or a composting bin and ensure the materials have adequate moisture not too much and not dry (i.e., once pressed the matter releases some drops of water). Introduce the red worms to break down the material. After 1.5 months, the compost will be fine and have low moisture. Use a 0.5 mm mesh to sieve the manure, separating the vermicompost from the worms. The compost is ready to use.

How to use vermicompost

Sprinkle into a seed row when planting. Add a handful of vermicompost to the hole during transplanting. Use as a top dressing or mulch around the base of the plant. Mix with potting soil for your house plants

Advantages of vermicompost

Improves soil physical structure, fertility, water retention, porosity, biological activity, resilience and resistance to pests and diseases. Improves plant germination, growth and yield. It adds plant growth hormones such as auxins and gibberellic acid into the soil. It contains earthworms cocoons and increases the population and activity of earthworms in the soil. Improves organic carbon availability.

Essentials that compost worms need A hospitable living environment, food, adequate moisture; adequate aeration, a shade to protect from extreme temperatures	**Harvesting of the vermicompost.** When harvesting, do not add new food to the beds for 2 weeks. After about 2-3 months, push the finished vermicompost over on one side. Add a batch of new bedding on the vacant side.	  

References

HLPE (High Level Panel of Experts) 2019. Agroecological and other Innovative Approaches for Sustainable Agriculture and Food Systems that Enhance Food Security and Nutrition; High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security: Rome, Italy, 2019. Available at https://www.fao.org/3/ca5602en/ca5602en.pdf

Sinclair, F., Wezel, A., Mbow, C., Chomba, S., Robiglio, V., & Harrison, R. (2019). The contribution of agroecological approaches to realizing climate-resilient agriculture. GCA: Rotterdam, The Netherlands.

Vikas, & Ranjan, R. (2024). Agroecological approaches to sustainable development. Frontiers in Sustainable Food Systems, 8, 1405409.

Wezel, A., Herren, B. G., Kerr, R. B., Barrios, E., Gonçalves, A. L. R., & Sinclair, F. (2020). Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. Agronomy for Sustainable Development, 40, 1-13.

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